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# टेलीविजन और ध्वनि संकेतों के लिए केबलकृत वितरण तंत्र – विशिष्टि

## भाग 3 सक्रिय समाक्ष वाइड बैंड वितरण संघटक

*Indian Standard*

# CABLED DISTRIBUTION SYSTEMS FOR TELEVISION AND SOUND SIGNALS — SPECIFICATION

## PART 3 ACTIVE COAXIAL WIDEBAND DISTRIBUTION COMPONENTS

UDC 621·397·743 : 621·375·12

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**BUREAU OF INDIAN STANDARDS**
**MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG**
**NEW DELHI 110002**

*July* 1995 **Price Group 8**

Radio Communications Sectional Committee, LTD 20

## FOREWORD

This Indian Standard ( Part 3 ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Radio Communications Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

The series of standards on cabled distribution system for television and sound signals comprise of the following parts:

Part 1 Safety requirements
Part 2 Electromagnetic compatibility for system and components ( *under preparation* )
Part 3 Active coaxial wideband distribution components
Part 4 Passive coaxial wideband distribution components
Part 5 Headend

This standard ( Part 3 ) states the minimum guaranteed performance requirements of certain parameters for active coaxial wideband distribution components and identifies the guaranteed performances specifications that shall be published by the manufacturers. It also lays down the basic methods of measurement of the operational characteristics of the active components in order to assess the performance of these components. This standard is largely based on IEC document 12G ( Sectt ) 129 'Cabled distribution system for television and sound signals: Part 3 Active coaxial wideband distribution components'.

For the purpose of deciding whether a particular requirement for this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values ( *revised* )'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

# *Indian Standard*

# CABLED DISTRIBUTION SYSTEMS FOR TELEVISION AND SOUND SIGNALS — SPECIFICATION

## PART 3 ACTIVE COAXIAL WIDEBAND DISTRIBUTION COMPONENTS

## 1 SCOPE

This standard

- applies to all broadband amplifiers used in cabled distribution systems.
- covers the frequeney range 5 MHz to 1 750 MHz.
- applies to one-way and two-way equipment.
- lays down the basic methods of measurement of the operational characteristics of the active components in order to assess the performane of these components.
- identifies the guaranteed performance specifications that shall be published by the manufacturers.
- states the minimum guaranteed performance requirements of certain parameters.

## 2 REFERENCES

The Indian Standards listed in Annex D are necessary adjuncts to this standard.

## 3 TERMS AND DEFINITIONS

For the purpose of this standard, the terms and definitions given in IS 13420 ( Part 1 ) : 1994 shall apply.

## 4 METHODS OF MEASUREMENT

This clause defines basic methods of measurement. Any equivalent method that ensures the same accuracy may be used for assessing performance.

Unless stated otherwise, all measurements shall be carried out with 0 dB plug-in attenuators and equalizers. The position of variable controls used during the measurements shall be published.

The test set-up shall be well matched over the specified frequency band.

### 4.1 Linear Distortion

### 4.1.1 *Return Loss Ratio*

The method described is applicable to the measurement of return loss ratio of equipment operating in the frequency range 5 MHz to 1 750 MHz.

All input and output ports of the unit shall meet the specification under all conditions of automatic and manual gain controls and with any combination of plug-in equalizers and attenuators fitted.

**4.1.1.1** *Equipment required*

a) A signal generator or sweep generator, adjustable over the frequency range of the equipment being tested.

Care shall be taken to ensure that the signal generator or sweep generator output does not have a high harmonic content as this can cause serious inaccuracy.

b) A VSWR bridge with built-in or separate RF detector.

The accuracy of measurement is dependent on the quality of the VSWR bridge. In particular on the directivity and on the return loss of the test port of the bridge. For example, Fig. 2 shows the maximum accuracy achieved by a bridge with 46 dB directivity and 26 dB return loss.

c) An oscilloscope.

d) Calibrated mismatches.

**4.1.1.2** *Connection of equipment*

The equipment shall be connected as in Fig. 1.

**4.1.1.3** *Measurement procedure*

NOTES

1 All coaxial input and output ports, other than those under test shall be terminated in 75 ohms.

2 Ensure that there is no supply voltage on the port being measured as this could damage the bridge. If it is necessary to use a voltage blocking device, use one with a good return loss ratio ( 10 dB better than requirement ).

3 Only good quality, calibrated connectors, adaptors and cables shall be used.

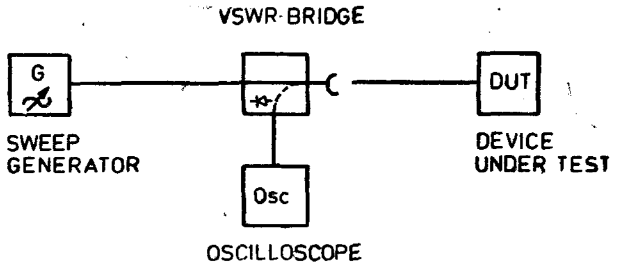


FIG. 1 MEASUREMENT OF RETURN LOSS RATIO

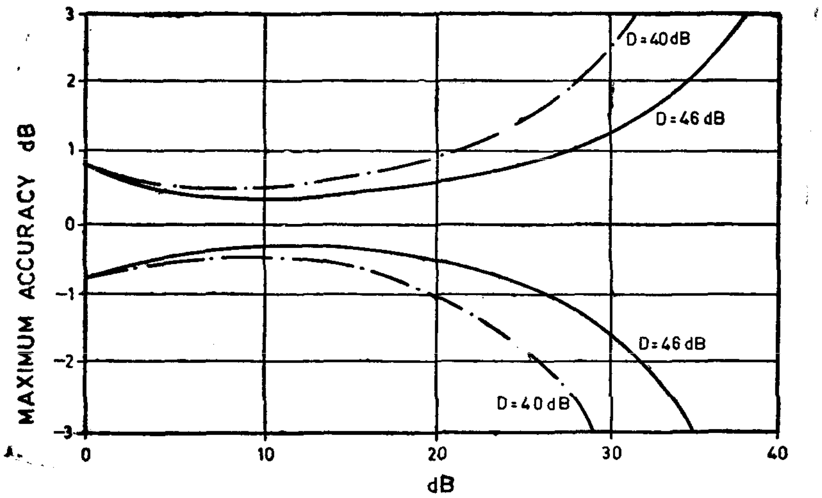


FIG. 2 MAXIMUM ACCURACY, A, FOR MEASUREMENT OF RETURN LOSS RATIO USING VSWR BRIDGE WITH DIRECTIVITY OF 46 dB AND TEST PART RETURN LOSS OF 26 dB.

The measurement procedure comprises the following steps:

a) Connect the equipment as shown in Fig. 1.

b) Set the signal generator output level such that the DUT is not overloaded.

c) Use the calibrated mismatches to calibrate the display on the oscilloscope.

d) Connect the DUT as shown in Fig. 1 and check the return loss over the specified frequency range.

### 4.1.2 *Flatness*

Methods of measurements are well known and a description of the procedure is not necessary.

### 4.1.3 *Chrominance/Luminance Delay Inequality*

Method of measurement as given in IS 13420 ( Part 1 ) : 1994 shall be applicable.

## 4.2 Non-Linear Distortion

### 4.2.1 *General*

In a non-linear device, the expression for the output signal will, in general, have an infinity of terms, each generated from one or more of the ( assumed sinusoidal ) terms in the input, and particularly by the interaction of two or more terms. The transfer function of the device can be expressed as:

$$V_{out} = a_0 + a_1 V_{in} + a_2 V_{in}^2 + a_3 V_{in}^3 + \dots\dots\dots + a_n V_{in}^n + \dots\dots \text{etc}$$

If the input signal $V_{in}$ has m sinusoidal terms, then this can be expressed as:

$$V_{in} = V_1 \sin(\omega_1 t + \phi_1) + V_2 \sin(\omega_2 t + \phi_2) + \dots\dots\dots V_m \sin(\omega_m t + \phi_m)$$

The output signal is then a series of terms each of which can be expressed in the general form:

$$C V_i a_n \sin(\omega_i t + \phi_i)$$

where

$\omega_i$ is the sum or difference of integral positive multiples of one or more of the input frequencies, for example:

$$4\omega_2,\ 2\omega_1 - \omega_3,\ 4\omega_1 + \omega_2,\ 2\omega_1 + \omega_2 + \omega_3$$

This may be written in a general form as

$$\omega_i = p_1\omega_1 \pm p_2\omega_2 \pm p_3\omega_3 \pm \dots\dots\dots \pm p_m\omega_m$$

where $p_1$, $p_2$, ..........., $p_m$ are positive integers ( including 0 )

$\phi_l$ is the relative phase of the output signal;

$a_n$ is a coefficient of the transfer function;

$V_l$ is a term dependent on the product of powers of the amplitudes of the input signals ( $V_1$, $V_2$, etc ) where the sum of the powers equals $n$; and

$C$ is a numerical multiplier.

It should be noted that terms at the same frequency may arise from several different terms in the transfer function, that is, for several different values of $n$.

Each component of the output signal represented by such an expression with $n > 1$ is a *non-linear distortion product*. Where $\omega_l$ is an integral multiple of a single term in the input signal, for example 4 $\omega_2$, the product is regarded as a *harmonic distortion product*. If it is formed from two or more terms, for example $2\omega_1 - \omega_3$, it is known as an *intermodulation distortion product*.

Since the values of $a_1$, $a_2$, $a_3$, etc, usually decrease relatively rapidly with increasing values of $n$, it is found that the predominant non-linear output signals arise from the terms in transfer function in such a way that the sum $p_1+p_2+$ ...... $p_m=n$. and $n$ is defined as the order of the non-linear distortion product, for example $3\omega_1 - 2\omega_3$ is a fifth order product arising from the term $a_5 V_{1n}{}^5$. The $m$ input signals represented in the expression are not necessarily distinct signals. Any periodic signal may be represented by a series of sinusoidal terms as in the expression for $V_{1n}$. For the predominant non-linear output signals it is found that:

$$V_l = V_1{}^{p1}\, V_2{}^{p2}\, V_3{}^{p3} \ldots\ldots\ldots\ldots V_m{}^{pm}$$

so that if the amplitudes of all the input signals are multiplied by a common factor $K$, the amplitude of the $n$-th order distortion products will be multiplied by $K^n$ (since $p_1+p_2+p_3$...... $p_m=n$). When the levels of all input signals are raised by 1 dB, the level of any signal $n$-th order distortion product will increase $n$ dB, and the resultant signal/distortion ratio will decrease by ( $n-1$ ) dB. This relationship will be referred to as the standard level variation of a distortion product. If a distortion product is due to components of different order, and/or different order products occur within the bandwidth of the device used to measure the level of distortion products, then the measured level will not follow a standard level variation. In principle, an infinite number of terms is necessary for a complete description of a non-linear characteristic. However, considering the standard level variation of terms of different order, the relative contribution of higher-order terms increases with the level of the input signals. Conversely, if signal levels are low enough, only a few of the lowest order terms will produce significant contributions at the output.

If all input signals are limited to a frequency band of less than one octave, the frequencies of all second-order terms will fall outside of the band limits. Signals frequencies can also be allocated in two or more non-contiguous bands in a manner that will place all second-order products, outside the bands.

Third-order distortion products, in particular the products that occur at frequencies represented by $p_3a$, $p_{3b}$, $p_{3c}$, $p_{3d}$, $p_{3f}$, $p_{3g}$, $p_{3h}$, $p_{3j}$ cannot be kept out of the band that contains the input signals. The accumulation of third-order distortion products may therefore be a limiting factor in the performance of a wide-band multi-channel distribution system.

Measurement related to the following phenomena are described:

- intermodulation between two or three single frequency signals.
- composite beats produced by a number of single frequency signals.
- composite crossmodulation between a number of single frequency signals.

No attempt is made to discuss the merits of the different methods in relation to the specification of equipment for cabled distribution systems, nor is there any attempt to indicate any equivalence between methods, in the sense that the results of one method may be derived from measurements made by another. In fact, the discussion should not be taken even to imply that the ranking of devices by measured non-linear distortion is independent of the method of measurement.

A proper specification shall include at least the following details:

a) the particular effect that is measured;

b) a list of input signals that produce this effect;

c) the frequency at which the effect is measured; and

d) the required signal to distortion ratio.

The result of the measurement shall be given as the worst case maximum signal level at the component output that allows the required signal to the distortion ratio to be met. If the output level is sloped with frequency, this must be defined.

The effect shall be defined as being of a particular order ( for example 'third-order intermodulation' ).

### 4.2.2 *Intermodulation*

#### 4.2.2.1 *Introduction*

The two carrier method described is applicable to the measurement of the ratio of the carrier to a single intermodulation product at a specified point within a cabled distribution system. The method can also be used to determine the intermodulation performance of individual items of equipment.

NOTE — It should be especially noted that the simultaneous use of many channels spaced by the same frequency interval results in a large number of intermodulation products ( particularly those of the third-order ) falling near the vision carrier of a wanted television channel.

In these cases, the resultant interference is of an extremely complex nature and an alternative measurement procedure will be needed. This is covered by **4.2.4**.

Examples of second-order and third-order intermodulation products are given in Annex A.

Second order products are encountered only in wideband equipment and systems covering more than one octave, and shall be measured using two signals ( *see* **A-1** ).

Third-order products are encountered in wideband and narrow-band equipment and systems and shall be measured using three signals ( *see* **A-2** ).

#### 4.2.2.2 *Equipment required*

a) A selective voltmeter covering the frequency range of the equipment or system to be tested. This may be spectrum analyser.

b) The appropriate number of signal generators covering the frequencies at which the tests are to be carried out.

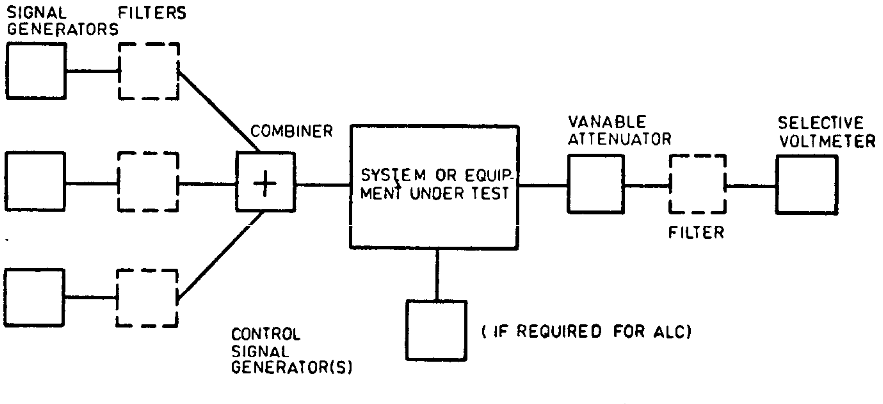
c) A variable attenuator with a range greater than the signal to intermodulation ratio expected, if not incorporated in the voltmeter described in **4.2.2.2**(a).

d) A combiner will be required for tests on equipment and systems with a single input ( Fig. 3 and Fig. 4 ).

NOTE — Additional items may be necessary, for example, to ensure the measurements are not affected by spurious signals generated in the test equipment itself ( Annex B ).

#### 4.2.2.3 *Connection of equipment*

The equipment shall be connected as shown in Fig. 3.



NOTES

1 The requirements for the items of test equipment indicated by dotted lines depends on the results of checks given in Annex B. The filters at the signal generator outputs may be needed to suppress spurious signals. The selective voltmeter input filter may be required to prevent intermodulation in the meter. If a filter is used, then possible mismatch should be avoided by not reducing the attenuator value below 10 dB.

2 To avoid intermodulation between the signal generators, it may be necessary for the combiner to be in the form of one or more directional couplers ( *see* Annex B ).

FIG. 3 BASIC ARRANGEMENT OF TEST EQUIPMENT FOR EVALUATION OF THE RATIO OF SIGNAL TO INTERMODULATION PRODUCT

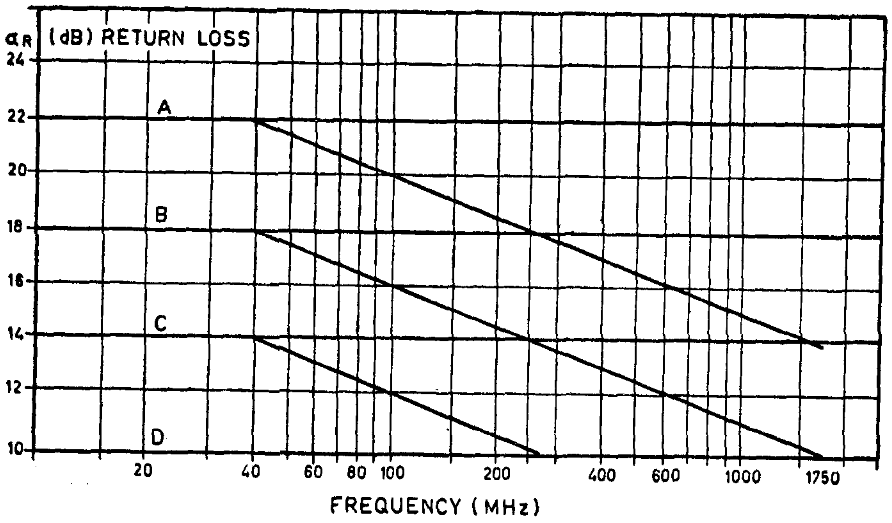


FIG. 4 GRAPHICAL REPRESENTATION OF RETURN LOSS CATEGORIES

**4.2.2.4** *Measurement procedure*

The measurement procedure comprises the following steps:

a) *General*

Unless otherwise required, the reference levels used in the measurements shall be the normal operating levels specified for the equipment or system. If the specified levels are not constant over the frequency range then the levels of all the test signals shall be quoted in the results.

Measurements of both second-order and third-order products shall be carried out with the test signals widely and closely spaced over each band of interest at frequencies capable of producing significant products within the overall frequency range. An exception to this is dealt with in **A-1.2**.

Where the system to be measured includes automatic gain control ( AGC ), tests shall be carried out at the nominal operating signal input levels.

b) *Calibration and checks*

A check shall be made to determine if harmonics and other spurious signals at the outputs of the signal generators are likely to affect materially the results of the measurements ( *see* Annex B ).

The selective voltmeter shall be calibrated and checked for satisfactory operation ( *see* Annex B ).

A check shall be made for possible intermodulation between the signal generators at the output levels to be used for the tests ( *see* Annex B ).

c) *Measurement*

Set the signal generators to the frequencies of the test signals [ *see* **4.2.2.4**(a) and Annex **A** ], and adjust their outputs and that of the different points of the systems as far as the point of measurement to obtain the specified system operating levels throughout.

Connect the variable attenuator and selective voltmeter and other items if required ( *see* Annex B ) to the point of measurement. Tune the meter to each test signal and note the attenuator value *a*1 required to obtain a convenient meter reading R for the reference signal. The attenuator value *a*1 should be slightly greater than the signal to intermodulation ratio expected at the point of measurement.

Tune the meter to the intermodulation product to be measured and reduce the setting of the variable attenuator to the value *a*2 required to obtain the same meter reading R.

NOTE — When measuring levels of intermodulation products, it may be necessary to insert a filter at the input to the meter ( *see* Annex B. ). In such instances the insertion loss ( in dB ) of the filter at the frequency of the products shall be added to the attenuator value.

The signal to intermodulation product ratio in dB is given by:

$$S/I_p = a1 - a2$$

where

$a1$ = attenuator value for the test signal used as a reference in dB, and

$a2$ = attenuator value for the intermodulation product in dB.

### 4.2.3 *Composite Triple Beat*

#### 4.2.3.1 *Introduction*

The method of measurement of composite triple beat using carrier wave (cw) signals is applicable to the measurement of the ratio of the carrier to composite triple beat at a specified point in a cabled distribution system. The method can also be used to determine the composite triple beat intermodulation performance of individual items of equipment.

When the input signals are at regularly spaced intervals ( as is common in most allocations for TV channels ), the various distortion products tend to cluster in groups, close to the vision carriers and at other regular positions within the TV channels. The number of different products in each cluster increases rapidly with the number of channels, and they combine in differrent ways, depending on the degree of coherence between generating signals, and the relative phases of the different distortion products.

The method described in this clause measures the non-linear distortion of a device or system by the composite effect of all the beats clustered within ± 15 kHz of the vision carrier of that channel has to be turned off, so that the composite triple beat measured is that generated by all carriers except that of the measured channel.

NOTE — On systems carrying more than 10 channels, removal of the wanted carrier does not significantly affect the result.

The method is used to support a specification of the following general format:

'The composite triple beat ratio for groups of carriers in channel (A) at (B) dB ($\mu$V) is (C) dB' where

(a) designates the channel in which the test is made. If omitted, the specification is understood to be a minimum specification for measurements at all the channels specified by the list of carriers.

(b) is the reference level at which all carriers should be set during the measurement unless otherwise specified. If all carriers are not at the same level, the specification should clearly indicate the level of each carrier relative to the reference level.

(c) is the composite triple beat ratio, usually given as a minimum specification.

Because of the large variety of frequency plans in use and the need to compare readily performance specifications of different manufacturers' equipment, the measurement for components shall be made with the carriers listed in Annex C ( the carriers are all in an 8 MHz raster, except for the special case of 48·25 MHz ).

The vision carrier frequencies are arranged in groups and only complete groups shall be used. If an amplifier is specified up to 450 MHz, group A shall be used. If specified to 550 MHz, groups A and B shall be used. If specified to 860 MHz, all groups A, B, C, D and E shall be used.

For amplifiers specified for intermediate upper limit frequencies the performance shall be quoted for the maximum possible number of complete groups. The manufacturer may, in addition, provide a performance figure for a large number of carriers.

#### 4.2.3.2 *Equipment required*

a) A spectrum analyser with 30 kHz IF bandwidth and 10 Hz video bandwidth capability.

NOTE — When using a spectrum analyser with minimum video filtering capabilities greater than 10 Hz, the composite third-order distortion may be noisy and should be read at the middle of the trace.

b) A variable 75 ohms attenuator, adjustable in 1 dB steps.

c) A bandpass filter for each channel to be tested or a tunable bandpass filter. This filter should attenuate the other channels present on the system to be tested sufficiently to ensure that the products generated by non-linearity in the spectrum analyser itself do not contribute significantly to the composite beat products to be measured. The passband of this filter shall at least be flat with 1 dB over the frequency range of interest, and shall be well matched over the complete frequency band. If necessary, a fixed attenuator shall be connected at the input to the filter.

d) CW generators, operating at the frequencies of the vision carriers used in the system to be tested. The tuning accuracy and stability shall be better than ± 5 kHz. The number of generators needed is governed by the number of groups of frequencies used for the tests ( *see* **4.2.3.1** ). Group A also can be used in part, dependent on the specified bandwidth of the equipment under test. The frequencies deleted shall be stated.

e) A combiner for the signals from the generators.

f) Matching devices, attenuators and filters, etc, to obtain the correct signal levels, matching conditions and reduction of spurious signals at the input of the system.

**4.2.3.3** *Connection of equipment*

The equipment shall be connected as in Fig. 5.

**4.2.3.4** *Measurement procedure*

The measurement procedure comprises the following steps:

a) Connect point *A* directly to point *B* and disconnect the bandpass filter ( *see* Fig. 5 ). Adjust the level of each generator for an output level at point *A* equal to that which will be present when the system or device under test is connected.

b) Adjust the spectrum analyser as follows:

| | |
|---|---|
| IF bandwidth | 30 kHz |
| Vide bandwidth | 10 Hz |
| Scan width | 50 kHz/div |
| Vertical scale | 10 dB/div |
| Scan time | 0·2 s/div |

c) Tune the spectrum analyser so that the vision carrier of the channel in which the measurement is to be made is centred on the display screen.

d) Adjust the sensitivity of the spectrum analyser together with its internal and external input attenuator in such a way that the response to the picture carrier corresponds to a full scale reference. At the same time the noise level shall be at least 10 dB lower than the distortion ratio required.

e) Insert the bandpass filter corresponding to the channel to be measured and adjust the input attenuator to correct for the attenuation of the filter.

f) Disconnect the generator for the channel to be measured and terminate the combiner with its nominal impedance.

g) Verify that the intermodulation products generated in the spectrum analyser over the entire channel are at least 20 dB below the distortion ratio required. If this is not the case, disconnect the bandpass filter and repeat the steps (d) to (g) of this procedure with decreased sensitivity of the spectrum analyser.

h) Note the setting of the sensitivity control.

j) Connect the signal generator again and repeat steps (c) to (h) of this procedure for all channels.

k) Connect the system to be tested between points *A* and *B* and reset the signal generators to obtain the required output levels at point *B*.

m) Adjust the centre frequency of the spectrum analyser as in step (c) and insert the appropriate bandpass filter.

n) Adjust the input attenuator ( internal or external ) to return the response of the spectrum analyser to the picture carrier to full scale with the appropriate setting of its sensitivity control [ *see* step (h) ].

p) Disconnect the generator for the channel to be measured and terminate the combiner with its nominal impedance.

q) The composite triple beats are clustered within ± 15 kHz of the vision carrier, so the signal/composite triple beat ratio can be read directly off the screen of the spectrum analyzer.

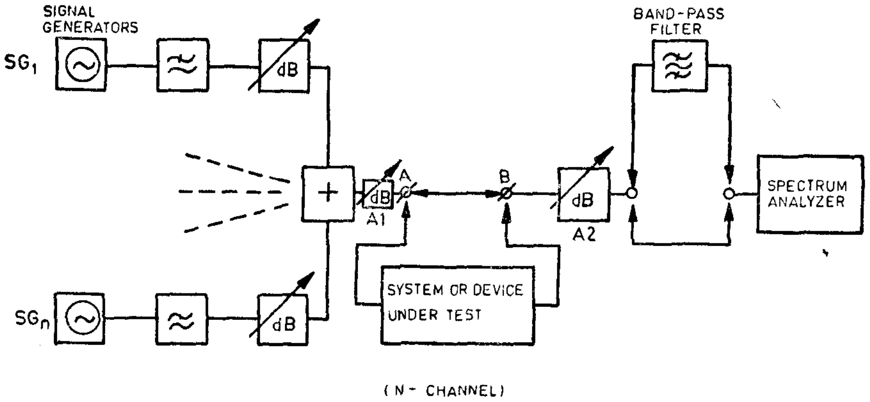


FIG. 5 CONNECTION OF TEST EQUIPMENT FOR THE MEASUREMENT OF NON-LINEAR DISTORTION BY COMPOSITE BEAT

r) Adjust the attenuator *A*1 of Fig. 5 to obtain the required signal/composite triple beat ratio and compensate for the change in output level using attenuator *A*2.

s) Measure the signal level at the output of the DUT.

t) Repeat the steps (m) to (s) of this procedure for every channel used in this test.

u) The worst case maximum output level giving the required signal to composite triple beat ratio shall be noted for publication.

### 4.2.4 *Composite Second Order Beat*

The test equipment required, connection of equipment and measurement procedure are as for the composite triple beat measurement but with the following differences.

#### 4.2.4.1 *Equipment required*

The test equipment required is the same as described in **4.2.3.2**.

#### 4.2.4.2 *Measurement procedure*

The procedure is as for composite triple beat except that the second order beats are not clustered ( ± 10 kHz ) about exact carrier frequencies but may be at ± 0·75 MHz or ± 0·25 MHz from them. The carrier/composite second order ratio can be read directly off the screen of the spectrum analyser.

For composite second order it is also necessary to measure the beats close to channel at 48·25 MHz or at the lowest possible channel. Although it is not essential to have the carrier present at this frequency, it may be useful for reference purposes. In this case, the second order beats are clustered around 48·00 MHz ±10 kHz and so again may be read directly from the screen of the spectrum analyser.

The worst case maximum output level giving the required signal to composite second order ratio shall be noted for publication.

### 4.2.5 *Composite Crossmodulation*

#### 4.2.5.1 *Introduction*

The multi-signal method of measurement is used The system or equipment output signal levels, that produce the required composite amplitude crossmodulation ratio and the composite total crossmodulation ratio ( both normally 60 dB ), are measured.

The method described is applicable to the measurement of crossmodulation by the transfer of modulation from multiple interfering modulated signals on to an unmodulated wanted signal.

Measurements are made using the same carrier frequencies as for composite second order that is as shown in Annex C.

The method uses multiple interferring signals modulated symmetrically about a level such that the voltage at the peak of the modulation envelope is equal to the reference level L, which is also the level of the unmodulated wanted signal.

A correction factor is included to allow for the use of modulation depths less than 100 percent ( *see* Table 3 ).

Composite amplitude crossmodulation is defined as the transfer of amplitude modulation from a number of modulated signals to the wanted carrier, and can be expressed as follows:

$$20 \log \frac{\text{p-p voltage of wanted amplitude modulation}}{\text{p-p voltage of transferred amplitude modulation}}$$

Composite total crossmodulation is defined as the transfer of total modulation, that is the vector sum of amplitude and phase modulation, from a number of modulated signals to the wanted carrier and can be expressed as follows:

$$20 \log \frac{\text{p-p voltage of wated sideband}}{\text{p-p voltage of transferred sideband}}$$

All signals are symmetrically 100 percent modulated and have rms voltages at the peaks of their modulation envelopes equal to the reference level L.

The measurement results obtained at the chosen depth of modulation are corrected to those which would be obtain with 100 percent d.c. coupled modulation ( *see* Table 3 ).

The device under test is measured at the maximum output signal level that will allow a particular wanted modulation/composite crossmodulation ratio to be achieved ( usually 60 dB ).

#### 4.2.5.2 *Conditions of measurement*

a) The measurements shall be carried out with all the input signals present. These shall be appropriate to the frequency range of the particular device under test and in accordance with the table in Annex C.

b) Where the equipment to be measured includes automatic gain control ( AGC ), tests shall be made at the input signals nominal operating levels.

c) All levels shall be expressed in rms values.

**4.2.5.3** *Equipment required*

a) An RF selective voltmeter covering the frequency range of the system or equipment to be tested having linear demodulated output facilities at the depths of modulation to be used and a bandwidth adequate to pass the desired AF sidebands without attenuation. If the selectivity and linearity of the voltmeter are not adequate to prevent the generation of spurious signals, it is essential that the bandpass filter shown in Fig. 6, is inserted. The RF selective voltmeter shall indicate the rms value of its input signal at the peaks of the modulation envolpe.

b) Signal generators covering the appropriate vision carrier frequencies as listed in Annex C, all having the required modulation facilities, linear at the depth of modulation to be used.

NOTE — It is recommended that the modulation frequency approximates the line scan frequency of the TV signals in order to include effects which may be caused by low frequency circuits ( for example decoupling ) in the equipment to be tested. The modulation frequency should not be a multiple of the power supply frequency.

Any symmetrical modulation waveform ( excluding pulse modulation ) may be used providing the same signal generator used for both calibration and measurement, and the modulation depth and waveform remain the same.

c) An AF selective voltmeter covering the modulation frequency to be used and having a calibrated input level range exceeding the expected crossmodulation ratio.

d) A combiner, matching devices, attenuators, filters, etc, to obtain the correct signal levels, matching and reduction of spurious signals.

e) A spectrum analyser with 3 kHz IF bandwidth and 10 Hz video bandwidth capability.

f) A bandpass filter for each channel to be tested or a tunable bandpass filter. This filter shall attenuate the other channels present on the system to be tested sufficiently to ensure that the products generated by non-linearity in the spectrum analyser itself do not contribute significantly to the crossmodulation products to be measured. The passband of this filter shall be flat at least to within 1 dB over the frequency range of interest, and shall be well matched over the complete frequency band. If necessary, a fixed attenuator shall be connected to the input of the filter.

**4.2.5.4** *Connection of equipment*

Connect equipment as shown in Fig. 6.

**4.2.5.5** *Measurement procedure*

The measurement procedure comprises the following steps:

Composite amplitude crossmodulation

a) Connect the output of the system or equipment under test to the RF selective voltmeter.

b) Select each signal generator in turn, set the modulation depth and adjust the

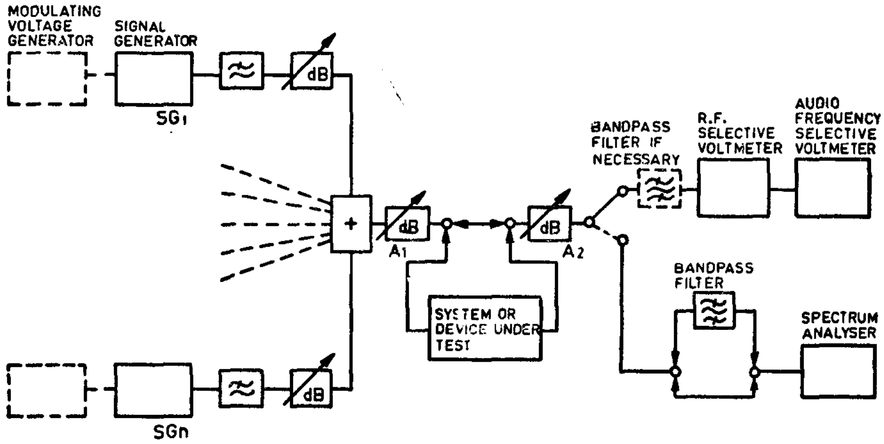

MODULATING VOLTAGE GENERATOR
SIGNAL GENERATOR
dB
SG1
BANDPASS FILTER IF NECESSARY
R.F. SELECTIVE VOLTMETER
AUDIO FREQUENCY SELECTIVE VOLTMETER
+
dB
A1
dB
A2
BANDPASS FILTER
SYSTEM OR DEVICE UNDER TEST
SPECTRUM ANALYSER
dB
SGn

FIG. 6 MEASUREMENT OF COMPOSITE CROSS MODULATION

output to give the desired r.f. peak level L at the output of the system or equipment to be tested using the RF selective voltmeter.

c) Tune the selective voltmeter to the frequency of the carrier selected as the wanted signal. Switch off all the unwanted signals. Adjust the AF selective voltmeter for a convenient reading of the demodulated signal. Note this reading.

d) Switch off the modulation on the selected wanted signal. Adjust its unmodulated output to give the desired RF level L at the output of the system or equipment to be tested, using the RF selective voltmeter.

e) Switch on all the modulated signals and, with the RF selective voltmeter tuned to the wanted carrier frequency, note the level of the demodulated amplitude crossmodulation signal on the AF selective voltmeter.

f) The difference in decibels between the levels obtained in steps (c) and (e), corrected as in Table 3, is the amplitude crossmodulation ratio referred to 100 per cent d.c. coupled modulation Adjust attenuator *A*1 of Fig. 6 and compensate for the change in output level using *A*2 in order to obtain the required composite amplitude crossmodulation ratio, normally 60 dB.

g) The worst case maximum output level giving the required signal to composite amplitude crossmodulation ratio shall be noted for publication.

Composite total crossmodulation

h) Connect the output of the system or equipment under test to the spectrum analyser.

j) Adjust the spectrum analyser as follows:

| | |
|---|---|
| IF bandwidth | 3 kHz |
| Video bandwidth | 10 Hz |
| Scan width | 5 kHz/div |
| Vertical scale | 10 dB/div |
| Scan time | 0.5 S/div |

k) Tune the spectrum analyser to the channel on which the measurement is to be made so as to display the vision carrier and a frequency range of 25 kHz either side of the carrier.

m) Switch off all other channels and switch on the modulation of the channel to be measured.

n) Insert the bandpass filter corresponding to the channel to be measured and adjust the input attenuator to correct for the attenuation of the filter.

p) Adjust the sensitivity of the spectrum analyser together with its internal and/or an external input attenuator in such a way that the response to the first sidebands, approximately 15 kHz on the either side of the picture carrier, corespond to a full scale reference. At the same time the noise level shall be at least 10 dB lower than the distortion ratio required.

q) Switch off the modulation of the wanted carrier and switch on all the other modulated carriers.

Measure the amplitude of the sidebands on either side of the wanted carrier caused by the total composite crossmodulation transfer. The difference in dB between the full scale reference and the largest of the two sidebands, corrected as in Table 3, is the total crossmodulation ratio referred to 100 percent d.c. coupled modulation. Adjust attenuator *A*1 of Fig. 6 and compensate for the change in output level using attenuator *A*2 in order to obtain the required total composite crossmodulation.

Repeat steps (a) to (p) of this procedure each time selecting a different wanted signal, until all channels used in this test have been selected.

The worst case maximum output level giving the required signal to composite total crossmodulation ratio shall be noted for publication.

#### 4.2.6 *Hum Modulation*

The method of measurement is given in IS 13420 ( Part 1 ) : 1994.

### 4.3 Unwanted Components of the Signal

#### 4.3.1 *Automatic Gain and Slope Control Step Response*

In cabled television systems using broadband amplifiers having automatic gain and slope controls, it is important to have carefully chosen control time constants to prevent instability when amplifiers are cascaded. Moreover, correctly chosen time constants are an advantage during measurements with CATV systems analysers.

The control time constant, Tc, is the time in which the effect on the output of a level step at the input of an amplifier is reduced to 50 percent of the instantaneous change.

NOTE — It is assumed that the control curve follows an exponential function. Contrary to the normal definition of a time constant, the 50 percent value has been chosen as more easily read on the display of a spectrum analyser ( *see* Fig. 8 ).

The following procedure is used on equipment using pilots.

**4.3.1.1** *Equipment required*

a) Two pilot frequency generators ( or one if only one pilot frequency is used ).

b) A combiner for the two pilot frequency generators.

c) One switched attenuator.

d) Two rotary switches.

e) Two cables with attenuation of 2 dB at the highest frequency of the amplifier frequency range.

f) A spectrum analyser with storage display.

**4.3.1.2** *Connection of equipment*

The equipment is connected as in Fig. 7.

**4.3.1.3** *Measurement procedure*

The measurement procedure comprises the following steps:

a) With the rotary switches RS1 and RS2 in position B ( no cables ), ensure that the pilot signals at the point *P* have the same value and that the input levels are in the normal operating range of the device under test.

b) Turn the rotary switch RS1 to position A ( cable 1 ) and connect the DUT. With a 2 dB plug-in equalizer ( or an additional 2 dB cable equalizer in front of the DUT ), the pilot signals will have the same level at the first stage of the amplifier.

c) Switch the DUT to automatic gain control. The two pilot frequencies on the spectrum analyser should have the normal level.

d) Tune to the upper pilot frequency using the spectrum analyser on the following settings:

| | |
|---|---|
| frequency span | 0 MHz |
| resolution bandwidth | 3 MHz |
| time/division | 0·5 s |
| dB/division | 1 dB |

e) Turn the rotary switch RS2 to position A ( negative step ) shortly after the start of the spectrum analyser scan. *See* Fig. 8. Measure the control time constant Tc.

f) Repeat the procedure with the rotary switches in the same start positions (RS 1 at A, RS2 at B ) and turn RS1 to position B ( no cable ) ( positive step ).

g) repeat the procedure for the lower pilot frequency.

h) A control time constant Tc between 2 and 4 seconds is typical.

**4.3.2** *Noise Figure*

The noise figure is a figure of merit describing the internally generated noise of an active device.

Normally the noise figure is measured using either a calibrated noise generator suitable for the required frequency range or, more conveniently, with an automatic noise figure meter using an excess noise source.

The following clauses describe the 'twice power' method of measurement using a calibrated noise generator.

**4.3.2.1** *Definition*

The noise figure is the ratio of the signal to noise ratio at the input to the signal to noise ratio at the output of an active device.

$$F = \frac{S1/N1}{S2/N2}$$

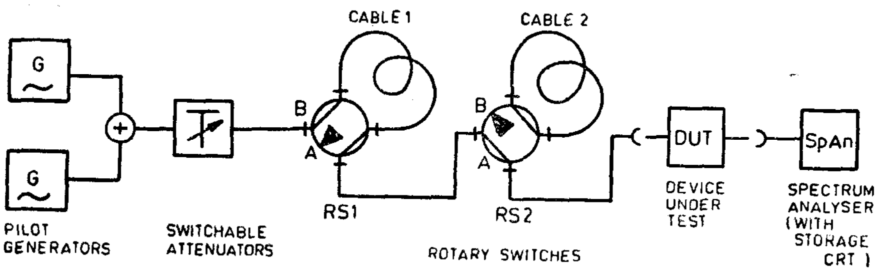


FIG. 7 MEASUREMENT OF AGC STEP RESPONSE

where

$S1$ = signal power at the input

$S2$ = signal power at the output

$N1$ = noise power at the input

$N2$ = noise power at the output

In other words, the noise figure is the ratio of noise power at the output of an active device to the noise power at the same point if the device had been ideal and added no noise:

$$F = \frac{N2 \text{ actual}}{N2 \text{ ideal}}$$

The noise figure is dimensionless and is often expressed in dB:

$$F\text{ ( dB )} = 10 \log F$$

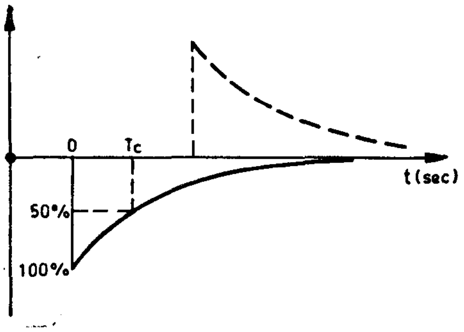


FIG. 8 TIME CONSTANT Tc

**4.3.2.2** *Equipment required*

a) A noise generator excess noise source suitable for the frequency range in use with dB-or KTo-calibration.

b) A 3 dB attenuator.

c) A frequency selective power meter ( voltmeter ).

**4.3.2.3** *Connection of equipment*

The equipment is connected as in Fig. 9. The connection between the noise generator and the DUT should be short. The impedance of all equipment should be 75 ohms.

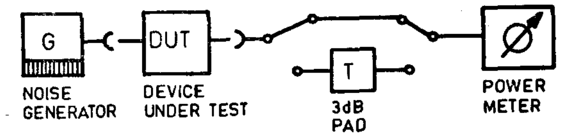


FIG. 9 MEASUREMENT OF NOISE FIGURE

**4.3.2.4** *Measurement procedure*

The measurement procedure comprises the following steps:

a) Set a convenient reference on the power meter at the wanted frequency without the 3 dB attenuator and without additional noise at the input port of the DUT ( noise generator turned off ). The measured noise level should be at least 10 dB higher than the indication of the power meter if its input is terminated in 75 ohms.

b) Insert the 3 dB attenuator and increase the noise generator output until the power meter returns to the original reference level.

c) Read the noise figure from the noise generator.

## 5 PERFORMANCE REQUIREMENTS

### 5.1 General requirements

Where the standard calls for performance figures to be published, these shall be stated, if appropriate, for each input and output port.

Published performance figures shall apply when the methods of measurement given in **4**, or equivalent methods, are used.

Service and installation instructions must be available.

### 5.2 Safety

The relevant safety requirements as laid down in IS 14231 ( Part 1 ) : 1995 shall be met.

### 5.3 E.M.C.

The relevant E.M.C. requirements as laid down in IS 14231 ( Part 2 ) ( *under preparation* ) shall be met.

### 5.4 Frequency Range

The frequency range or ranges, over which the equipment is specified, shall be published.

### 5.5 Impedance and Return Loss Ratio

The nominal impedance shall be 75 ohms.

Amplifier return loss requirements are dependent on its position and purpose in the system. Table 1 below shows the required return loss category for the two quality grades of amplifiers.

**Table 1 Amplifier Classification and Return Loss Requirement**

| Amplifier Quality Grade | Return Loss Category |
|---|---|
| 1 | B |
| 2 | C |

Quality grade 1 contains typically amplifiers intended to be cascaded, quality grade 2 amplifiers are used typically within an apartment block, or within a single residence, to feed a few outlets.

The performance requirements for each return loss category is given in Table 2.

**Table 2 Return Loss Requirements for All Components**

( *Clause* 5.5 )

| Category | Frequency | Return Loss Requirements |
|---|---|---|
| A | 5-40 MHz | $\geqslant$ 22 dB |
| | > 40 MHz | $\geqslant$ 22 dB — 1·5 dB/Octave above 40 MHz |
| | | $\geqslant$ 14 dB at 1750 MHz |
| B | 5-40 MHz | $\geqslant$ 18 dB |
| | > 40 MHz | $\geqslant$ 18 dB — 1·5 dB/Octave above 40 MHz |
| | | $\geqslant$ 10 dB at 1750 MHz |
| C | 5-40 MHz | $\geqslant$ 14 dB |
| | > 40 MHz | $\geqslant$ 14 dB — 1·5 dB/Octave above 40 MHz |
| | but | $\geqslant$ 10 dB up to 1750 MHz |
| D | 5-1750 MHz | $\geqslant$ 10 dB |

Manufacturers shall state the return loss category of each amplifier.

**5.6 Gain**

The minimum full gain of the amplifier, in dB, at the highest specified frequency shall be published.

**5.6.1** *Gain Control*

The range in dB of any gain control shall be published.

**5.6.2** *Slope and Slope Control*

The characteristic of fixed slope, if fitted, shall be published. This shall be in the form of a formula showing the relationship between attenuation, in dB, and frequency, or, the particular test cable used for factory test shall be stated.

The range, in dB, of any variable slope control, relative to the mean value, shall be published.

**5.7 Flatness**

Flatness shall be published as a maximum deviation, in ± dB, from the average value of amplitude response. The average value is the mean value of the amplitude response curve, in dB, plotted against linear frequency over the published frequency range. Slope is assumed to be eliminated either by calculation or by cable.

The flatness specification shall be achieved in all conditions of automatic and manual gain control and also with any combination of plug-in equalizers and attenuators provided. Maximum deviation, at the highest frequency specified, relative to the average value, shall be published or taken into account in the published minimum full gain.

**5.8 Test Points**

Test point shall be 75 ohms or adapted 75 ohms through a test probe. The return loss shall be as for category B of Table 3. The attenuation and flatness shall be published.

**Table 3 Correction Factor**

( *Clauses* 4.2.5.1, 4.2.5.5 *and* 5.8 )

| Modulation ( ac coupled ) percent | Correction to be Added to Measured Ratio dB | |
|---|---|---|
| 100 | 0 | |
| 90 | 0·4 | |
| 80 | 0·9 | |
| 70 | 1·4 | |
| 60 | 1·9 | Correction factors where the modulation used is other than 100 percent |
| 50 | 2·5 | |
| 40 | 3·1 | |
| 30 | 3·7 | |

**5.9 Group Delay**

**5.9.1** *Chrominance/Luminance Delay Inequality*

The worst case delay inequality, in nanoseconds, between the luminance and chrominance ( 4.43 MHz ) with a single television channel, shall be published. The worst case channels shall be identified by frequency.

**5.9.2** *Other Television Standards and Modulation Systems*

These shall be measured over the nominal channel bandwidth and the worst case figure shall be published.

### 5.10 Noise Figure

The maximum noise figure, in dB, over the specified frequency range shall be published.

### 5.11 Non-linear Distortion

If the amplifier is designed for sloped operation, measurements shall be carried out with sloped output.

Measurements of composite distortions in amplifiers carrying multiple FM television signals are under consideration.

#### 5.11.1 *Second Order Distortion*

The two carrier method is used for amplifiers operating above 860 MHz, for return path amplifiers operating below 70 MHz and for amplifiers used for carrying FM signals.

The worst case value shall be published as the output level in dB ( $\mu$V ), that gives 60 dB signal to distortion ratio, or 40 dB for amplifiers carrying only FM signals in the passband.

#### 5.11.2 *Third Order Distortion*

The three carrier method is used for amplifiers operating above 860 MHz, for return path amplifiers operting below 70 MHz and for amplifiers used for carrying FM signals.

The worst case value shall be published as the output level in dB ( $\mu$V ), that gives 60 dB signal to distortion ratio, or 40 dB for amplifiers carrying only FM signals in the passband.

#### 5.11.3 *Composite Triple Beat ( CTB )*

The worst case value over all channels shall be published as the output level in dB ( $\mu$V ), that gives 60 dB signal to distortion ratio.

NOTE — For some amlifiers ( for example, feed forward ) it may not be possible to measure 60 dB distortion, in these cases, the output level for a greater signal to distortion ratio may be stated.

#### 5.11.4 *Composite Second Order ( CSO )*

The worst case value over all channels shall be published as the output level in dB ( $\mu$V ), that gives 60 dB signal to distortion ratio.

NOTE — For some amplifiers ( for example, feed forward ) it may not be possible to measure 60 dB distortion, in these cases, the output level for a greater signal to distortion ratio may be stated.

#### 5.11.5 *Composite Crossmodulation*

The worst case value over all channels shall be published as the output level in dB ( $\mu$V ) that gives 63 dB signal to distortion ratio. Two figures are required to be published. These correspond to the transfer of amplitude modulation only, as measured by amplitude demodulation, and to total modulation transfer as measured on a spectrum analyser.

NOTE — For some amplifiers ( for example, feed forward ) it may not be possible to measure 60 dB distortion, in these cases, the output level for a greater signal to distortion ratio may be stated.

### 5.12 Automatic Gain and Slope Control

The pilot frequencies and the dynamic range shall be published. Dynamic range is defined as the minimum and maximum input level variations, in dB, which can be compensated by the amplifier at the highest frequency. Maximum variation in the output level, corresponding to the input level variations for the specified dynamic range and over the specified temperature range, shall be published.

### 5.13 Hum Modulation

The feed through current producing 60 dB reference modulation to hum modulation ratio shall be published.

If a switching mode power supply is incorporated, reference carrier to spurious modulation ratio, in dB, shall also be published.

### 5.14 Power Supply

The following shall be published:

Input ac rms voltage and frequency range.

Power consumption to complete amplifier assembly or to each active module.

For the modular amplifier, the dc current and voltage required for each active module.

The worst case peak to peak ripple voltage, if the supply voltage is available for external use.

### 5.15 Environmental

Manufacturers shall publish environmental information on their products to enable users to judge their suitability with regard to four main requirements; storage, transportation, installation and operation.

The presentation of the information shall conform with the requirements of the following publications:

| | |
|---|---|
| **5.15.1** *Storage* ( simulated effects of ) | IS 9001 ( Part 14 ) : 1979 |

**5.15.2** *Transportation*

| | |
|---|---|
| Air freight ( combined cold and low pressure ) | IS 9000 ( Part 31 ) : 1978 |
| Road Transport ( bump test ) | IS 9000 ( Part 7/Sec 2 ) : 1979 |
| Road Transport ( shock test ) | IS 9000 ( Part 7/Sec 1 ) : 1979 |

**5.15.3** *Installation or Maintenance*

| | |
|---|---|
| Drop and Topple test | IS 9000 ( Part 7/Sec 3 ) : 1979 |
| Free fall test | IS 9000 ( Part 7/Sec 4 ) : 1979 |

**5.15.4** *Operation*

IP Class, Protection provided by enclosures

Climatic category of component or equipment for storage and operation as defined in following publications:

| | |
|---|---|
| General | IS 9000 ( Part 1 ) : 1988 |
| Cold | IS 9000 ( Part 2/Sec 1-4 ) : 1977 |
| Dry heat | IS 9000 ( Part 3/Sec 1-5 ) : 1977 |
| Damp heat | IS 9000 ( Part 5/Sec 1-2 ) : 1981 |
| Vibration ( sinusoidal ) | IS 9000 ( Part 8 ) : 1981 |

### 5.16 Markings

**5.16.1** Each component shall be legibly and indelibly marked with the following:

a) Manufacturer's name or trade-mark,
b) Serial number, and
c) Country of manufacture.

**5.16.1.1** It is recommended that appropriate symbols shall be used, when marking ports.

**5.16.2** *BIS Certification Marking*

The Components may also be marked with the Standard Mark.

**5.16.2.1** The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers and producers may be obtained from the Bureau of Indian Standards.

### 5.17 M.T.B.F.

The M.T.B.F. value for each complete amplifier, or for each module in modular amplifiers, shall be published.

It shall be stated whether the value is based on calculation or on statistical evidence.

If calculated, the method shall be defined.

# ANNEX A

( *Clauses* 4.2.2.1, *and* 4.2.2.4 )

## TEST CARRIERS, LEVELS AND INTERMODULATION PRODUCTS

### A-1 TWO SIGNAL TESTS FOR SECOND AND THIRD ORDER PRODUCTS

### A-1.1 Intermodulation Products with Test Signals at Frequencies $f_b$ and $f_a$

Second order ( *see* note ) :

$$P2_a = f_b - f_a$$
$$P2_b = f_a + f_b$$

Third order

$$P3_a = 2f_a - f_b \text{ where } 2f_a > f_b$$
$$P3_a = f_b - 2f_a \text{ where } 2f_a < f_b$$
$$P3_b = 2f_b - f_a$$
$$P3_c = 2f_a + f_b$$
$$P3_d = 2f_b + f_a$$

NOTE — Not applicable to narrow-band equipment unless the frequency range covered by the equipment is such that $2f_{min} < f_{max}$.

### A-1.2 Signal Levels

The two test carriers shall be set to the reference level.

### A-2 THE SIGNAL TESTS FOR THIRD ORDER PRODUCTS

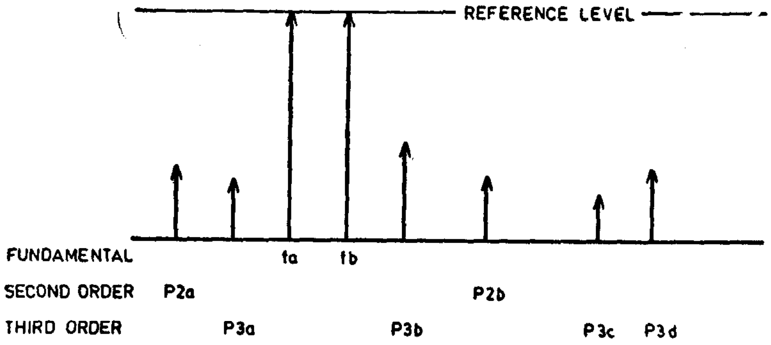
### A-2.1 Intermodulation Products with Test Signals at Frequencies

$f_a, f_b$ and $f_c$

Third order :

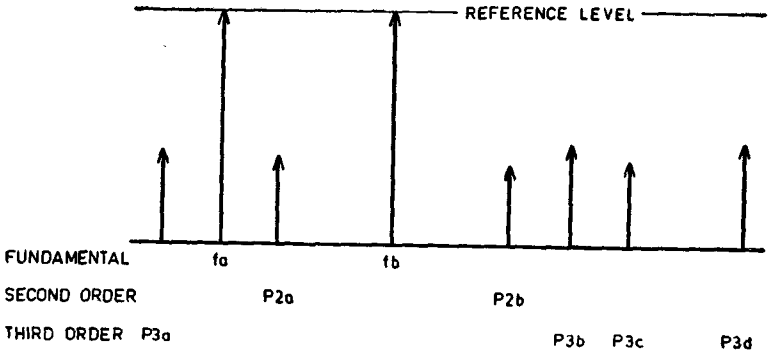
$$P3_f = f_a + f_b - f_c$$
$$P3_g = f_a + f_c - f_b$$
$$P3_h = f_b + f_c - f_a$$
$$P3_j = f_a + f_b + f_c$$

NOTE — Second and third order products due to any two of the test carriers will also be present if they fall within the frequency range of the equipment or system to be tested.



NOTE — The sequence of the intermodulation products will depend on the fundamental frequencies chosen.

FIG. 10 AN EXAMPLE SHOWING PRODUCTS FORMED WHEN $2f_a > f_b$.



NOTE — The sequence of the intermodulation products will depend on the fundamental frequencies chosen.

FIG. 11 AN EXAMPLE OF PRODUCTS FORMED WHEN $2f_a < f_b$.

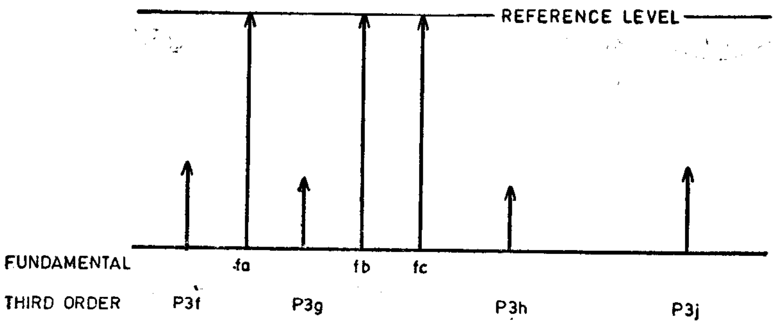


FIG. 12 PRODUCTS OF THE FORM $f_a \pm f_b \pm f_c$

## ANNEX B

( *Clauses* 4.2.2.2 *and* 4.2.2.4 )

### CHECKS ON TEST EQUIPMENT

### B-1 HARMONICS ( AND OTHER SPURIOUS SIGNALS ) IN GENERATOR OUTPUTS

Connect the selective voltmeter to one of the signal generators and determine the level of any spurious signals when the fundamental output is set to the level required for the test. If the ratio of fundamental to spurious signals is less than 30 dB, a filter should be inserted to reject the unwanted signals such that this ratio is achieved. All test signal generators shall be checked.

### B-2 INTERMODULATION IN THE SELECTIVE VOLTMETER

Check the accuracy of the amplitude scale of the selective voltmeter using one of the signal generators and the variable attenuator.

Connect the equipment as for measurement of intermodulation and tune the voltmeter to an appropriate product, adjusting the attenuator as necessary to obtain a convenient reading. Check that a small change, say 3 dB, in the attenuator setting produces an equivalent change in the meter reading. If the changes do not correspond, a filter should be inserted at the input to the meter to reduce the level of one or more of the test signals.

### B-3 INTERMODULATION BETWEEN SIGNAL GENERATORS

Care should be taken to ensure that the intermodulation measurements are not affected by intermodulation between the signal generators. Check by inserting a 6 dB attenuator between the combiner output and the equipment or system under test and adjusting each generator output by the same amount to restore the original input test levels. If this gives rise to a change in the levels of the measured intermodulation products, then the isolation between the generator outputs should be increased.

## ANNEX C

( *Clauses* 4.2.3.1, 4.2.5.1, 4.2.5.2 *and* 4.2.5.3 )

### CHANNEL ALLOCATION FOR CTB, CSO AND XMOD MEASUREMENT

| Frequency ( MHz ) | |
|---|---|
| 48.25 | GROUP A |
| 119.25 | |
| 175.25 | |
| 191.25 | |
| 207.25 | |
| 223.25 | |
| 231.25 | |
| 247.25 | |
| 263.25 | |
| 287.25 | |
| 311.25 | |
| 327.25 | |
| 343.25 | |
| 359.25 | |
| 375.25 | |
| 391.25 | |
| 407.25 | |
| 423.25 | |
| 439.25 | |

| Frequency ( MHz ) | |
|---|---|
| 447.25 | GROUP B |
| 463.25 | |
| 479.25 | |
| 495.25 | |
| 511.25 | |
| 527.25 | |
| 543.25 | |
| 567.25 | GROUP C<br>( last channel in band IV ) |
| 583.25 | |
| 599.25 | |
| 633.25 | GROUP D |
| 679.25 | |
| 695.25 | |
| 711.25 | |
| 727.25 | |
| 743.25 | |
| 759.25 | GROUP E |
| 775.25 | |
| 791.25 | |
| 807.25 | |
| 823.25 | |
| 839.25 | |
| 855.25 | |

## ANNEX D

( *Clause* 2 )

### LIST OF REFERRED INDIAN STANDARDS

| *IS No.* | *Title* |
|---|---|
| 9000 | Basic environmental testing procedures for electronic and electrical items: |
| ( Part 1 ) : 1988 | General |
| ( Part 2/ Sec 1-4 ) : 1977 | Cold test, |
| | Section 1 General |
| | Section 2 Cold test for non-heat dissipating items with sudden change of temperature |
| | Section 3 Cold test for non-heat dissipating items with gradual change of temperature |
| | Section 4 Cold test for heat dissipating items with gradual change of temperature |
| ( Part 3/ Sec 1-5 ) : 1977 | Dry heat test, |
| | Section 1 General |

| *IS No.* | *Title* |
|---|---|
| | Section 2 Dry heat test for non-heat dissipating items with sudden change of temperature |
| | Section 3 Dry heat test for non-heat dissipating items with gradual change of temperature |
| | Section 4 Dry heat test for heat dissipating items with sudden change of temperature |
| | Section 5 Dry heat test for heat dissipating items with gradual change of temperature |
| ( Part 5/ Sec 1-2 ) : 1981 | Dampheat ( cyclic ) test, |
| | Section 1 16 + 8 h cycle |
| | Section 2 12 + 12 h cycle |
| ( Part 7/ Sec 1-4 ) : 1979 | Impact test, |
| | Section 1 Shock test |
| | Section 2 Bump test |
| | Section 3 Drop and topple test |
| | Section 4 Free fall test |
| ( Part 8 ) : 1981 | Vibration ( sinusoidal ) test |
| ( Part 31 ) : 1978 | Combined cold/low air pressure test |
| 9001 ( Part 14 ) : 1979 | Guidance for environmental testing: Part 14 Storage test |
| 13420 ( Part 1 ) : 1994 | Cabled distribution systems: Part 1 Systems primarily intended for sound and television signals operating between 30 MHz and 1 KHz ( *first revision* ) |
| 13696 : 1993 | Interconnection of radio and TV receivers |
| 14231 | Cabled distribution system for television and sound signals: |
| ( Part 1 ) : 1995 | Safety requirements |
| ( Part 2 ) : 1995 | Electromagnetic compatibility for components and systems ( *under preparation* ) |

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